CUET UG 2026 Biology May 20 Shift 1 Question Paper with Solutions PDF

Question Paper with Solutions

Conducted by the National Testing Agency (NTA)

Time Allowed: 60 Minutes **Maximum Marks: 250**

General Instructions

(i) This is the Biology question paper of CUET (UG) 2026, conducted by the National Testing Agency (NTA) in Computer Based Test (CBT) mode.

(ii) The paper contains 50 multiple choice questions. All questions are compulsory.

(iii) The duration of this test paper is 60 minutes. The maximum score is 250 marks.

(iv) Each question has four options. Select the one correct answer for each question.

(v) Marking scheme: $+5$ marks for a correct answer, -1 mark for an incorrect answer, and 0 marks for an unanswered question.

(vi) For questions based on a passage or table, read the given material carefully and answer the questions that follow.

Questions (250 marks)

1. Identify the chemicals produced by *Calotropis* that provide defense against grazers and browsers.

[5 marks]

(A) Strychnine

(B) Quinine

(C) Cardiac glycosides

(D) Caffeine

Correct Answer: (C) Cardiac glycosides

Solution:

Concept:

- Plants cannot escape from a grazing animal by moving away, so they possess morphological or chemical defences. A chemical defence reduces feeding by making the plant toxic or unpalatable.
- Calotropis produces highly poisonous cardiac glycosides. These compounds affect cardiac function and discourage herbivores from eating the plant.

Step 1: Identify the plant-specific defence The question asks for the defensive chemical of Calotropis rather than for any poisonous plant compound. In the NCERT account of plant–herbivore interactions, Calotropis is the specific example associated with cardiac glycosides. Their toxicity helps protect the leaves and other plant tissues from grazers and browsers.

Step 2: Distinguish the other plant chemicals Strychnine, quinine and caffeine are biologically active plant compounds, but they are not the named chemical defence of Calotropis in this example. Strychnine is a toxic alkaloid, quinine is associated with Cinchona, and caffeine is associated with plants such as coffee. The mere fact that a substance is an alkaloid or can affect animals does not make it the correct association here.

Step 3: Conclusion The defensive chemicals produced by *Calotropis* are cardiac glycosides. Hence, the correct option is (C).

Quick Tip to Solve: Associate Calotropis with cardiac glycosides; do not substitute another familiar toxic plant chemical.

2. Match List-I with List-II

List-I (Organisms)	List-II (Trophic levels)
(A) Man, lion	(I) Third
(B) Zooplankton, cow	(II) First
(C) Phytoplankton, trees	(III) Fourth
(D) Birds, wolves	(IV) Second

Choose the correct answer from the options given below: [5 marks]

(A) (A) - (II), (B) - (III), (C) - (I), (D) - (IV)

(B) (A) - (IV), (B) - (I), (C) - (III), (D) - (II)

(C) (A) - (III), (B) - (IV), (C) - (II), (D) - (I)

(D) (A) - (I), (B) - (IV), (C) - (III), (D) - (II)

Correct Answer: (C) (A) - (III), (B) - (IV), (C) - (II), (D) - (I)

Solution:

Concept:

- A trophic level is the feeding position occupied by an organism in a food chain. Producers form the first trophic level and herbivores, or primary consumers, form the second.
- Secondary consumers occupy the third trophic level, while tertiary consumers occupy the fourth. Use the representative food-chain roles indicated by the listed groups.

Step 1: Assign producers and primary consumers Phytoplankton and trees prepare organic food by photosynthesis, so group (C) belongs to the first trophic level, code (II). Zooplankton feeding on phytoplankton and cows feeding on vegetation are primary consumers, so group (B) belongs to the second trophic level, code (IV). These two direct matches eliminate all options except the third combination.

Step 2: Complete and check the consumer matches In the representative trophic-level sequence used in the question, birds and wolves are secondary consumers at the third trophic level, code (I). Man and lion represent tertiary consumers at the fourth trophic level, code (III). Thus the complete matching is (A)–(III), (B)–(IV), (C)–(II), (D)–(I). The first, second and fourth combinations assign producers or primary consumers to incorrect positions. An organism can occupy different levels in different actual food chains; here the question uses their stated representative roles.

Step 3: Conclusion Producers occupy the first level, primary consumers the second, secondary consumers the third and tertiary consumers the fourth, giving the third matching combination. Hence, the correct option is (C).

Quick Tip to Solve: First match trees and phytoplankton to the first trophic level, then match herbivores to the second; these anchors identify the combination.

3. The species confined to a particular region and not found anywhere else is: [5 marks]

(A) Cosmopolitan

(B) Endemism

(C) Hot-spot

(D) Alien species

Correct Answer: (B) Endemism

Solution:

Concept:

- Endemism is the occurrence of a species within a particular geographical region, with that species naturally absent from other regions.
- Geographical restriction differs from widespread distribution, introduction outside a native range, and the identification of an entire conservation-rich region.

Step 1: Recognise the defining geographical restriction The decisive words are confined to a particular region and not found anywhere else. They describe the restricted natural distribution of an endemic species. The phenomenon or condition of such restriction is called endemism, which is the term supplied among the answer choices. A species endemic to an island or mountain region need not be widespread elsewhere.

Step 2: Separate the other ecological terms Cosmopolitan describes a species with a very wide distribution, so it is the opposite of the restriction in the question. A biodiversity hot-spot is a region recognised for high endemism and serious threat to its biodiversity, rather than the name of the distribution condition itself. An alien species has been introduced beyond its native geographical range; introduction does not define a species restricted naturally to just one region. Therefore none of those three terms answers the definition as directly as endemism.

Step 3: Conclusion The described condition is endemism; the species concerned is called endemic. Hence, the correct option is (B).

Quick Tip to Solve: Use the phrase found naturally nowhere else as the cue for endemic species and endemism.

4. Identify the correct reasons for cutting and clearing of Amazon rain forest?

(A) Cultivating soyabeans

(B) Growing wheat and maize

(C) Setting up industries

(D) Conversion to grasslands for raising beef cattle

Choose the correct answer from the options given below: [5 marks]

(A) (A), (B) and (D) only

(B) (A) and (D) only

(C) (B) and (C) only

(D) (A) and (C) only

Correct Answer: (B) (A) and (D) only

Solution:

Concept:

- Deforestation is the conversion of forest to another land use. In the Amazon example, large areas have been cleared for soybean cultivation and for grasslands used to raise beef cattle.
- Evaluate the lettered statements before selecting the combination; a generally possible land use is not automatically one of the specific causes listed in the textbook example.

Step 1: Identify the two stated conversions Statement (A), cultivating soyabeans, agrees with the expansion of agriculture into cleared Amazon forest. Statement (D), converting forest into grasslands for raising beef cattle, agrees with the establishment of cattle pasture. Both conversions remove the original forest vegetation and replace the diverse forest habitat with land managed for production.

Step 2: Reject the unsupported combinations Statement (B), growing wheat and maize, is not the crop-conversion cause identified in this Amazon example; soybean cultivation is the relevant one. Statement (C), setting up industries, is also not one of the two specified reasons. The first option includes the unsupported statement (B), while the third includes both (B) and (C). The fourth includes (C) and omits cattle pasture. Only the second option retains exactly statements (A) and (D), without adding an incorrect statement.

Step 3: Conclusion The correct reasons are cultivating soyabeans and conversion to grasslands for raising beef cattle. Hence, the correct option is (B).

Quick Tip to Solve: For the Amazon example, remember the linked land uses soybean fields and beef-cattle pastures, then select their statement letters.

5. Which one of the following is a inhibitor genes in *lac* operon? [5 marks]

(A) Gene *i*

(B) Gene *z*

(C) Gene *y*

(D) Gene *a*

Correct Answer: (A) Gene *i*

Solution:

Concept:

- The lac operon is an inducible system in bacteria that regulates the enzymes needed for lactose utilisation. Its regulatory gene and its structural genes perform different functions.
- The regulatory gene i codes for the repressor protein. The structural genes z, y and a code for beta-galactosidase, permease and transacetylase, respectively.

Step 1: Identify the inhibitory component In the absence of an inducer, the repressor binds to the operator region. This prevents effective transcription of the structural genes by RNA polymerase. Because gene i produces this repressor, it is the inhibitor or regulatory gene referred to in the question. The gene itself is DNA; the inhibitory action is carried out by its protein product.

Step 2: Distinguish the structural genes Gene z produces beta-galactosidase, which hydrolyses lactose. Gene y produces permease, which increases the entry of lactose into the bacterial cell. Gene a produces transacetylase. These three genes therefore specify enzymes rather than the repressor, eliminating options (B), (C) and (D). When the inducer binds to the repressor, it inactivates the repressor and permits expression of these structural genes.

Step 3: Conclusion Gene *i* is the inhibitor gene of the lac operon because it encodes the repressor. Hence, the correct option is (A).

Quick Tip to Solve: Remember the functional contrast: i makes the inhibitor, while z, y and a specify the three structural-gene products.

6. The scientist who developed a method for sequencing the DNA fragments was: [5 marks]

(A) Frederick Griffith

(B) Frederick Sanger

(C) George Gamow

(D) Har Gobind Khorana

Correct Answer: (B) Frederick Sanger

Solution:

Concept:

- DNA sequencing determines the order of nucleotide bases in a DNA molecule or fragment. It is distinct from discovering transformation or proposing the genetic code.
- Frederick Sanger developed the widely used method of DNA sequencing based on chain termination.

This method became important for sequencing DNA fragments in genome projects.

Step 1: Associate sequencing with the correct scientist Frederick Sanger developed a method for determining the nucleotide sequence of DNA. In the chain-termination method, normal DNA synthesis is interrupted by special terminating nucleotides. The resulting fragments of different lengths reveal the base sequence when analysed. Thus the task named in the question, sequencing DNA fragments, directly identifies Sanger.

Step 2: Separate the other contributions Frederick Griffith demonstrated bacterial transformation through experiments with pneumococci; he did not develop this DNA-sequencing method. George Gamow proposed ideas about the triplet nature of the genetic code. Har Gobind Khorana made major contributions to deciphering the genetic code using synthetic nucleic acids. These contributions concern different questions in molecular biology, so options (A), (C) and (D) do not match the stated development.

Step 3: Conclusion Frederick Sanger developed the method for sequencing DNA fragments. Hence, the correct option is (B).

Quick Tip to Solve: Link Sanger with sequencing, Griffith with transformation, and Khorana with deciphering the genetic code.

7. Which one of the followings is not a terminator codon? [5 marks]

(A) UAA

(B) UAG

(C) UUC

(D) UGA

Correct Answer: (C) UUC

Solution:

Concept:

- A codon is a sequence of three bases in messenger RNA. Most codons specify an amino acid, while three codons signal the termination of translation.
- The standard terminator or stop codons are UAA, UAG and UGA. They do not specify an amino acid and are recognised through the termination machinery rather than an amino-acid-carrying tRNA.

Step 1: Compare the options with the stop-codon set UAA is a stop codon, so option (A) is a terminator. UAG is also a stop codon, eliminating option (B) as an answer to a question asking which is not a terminator. UGA is the third standard stop codon, so option (D) must likewise be excluded. The negative word in the question requires the one codon outside this set.

Step 2: Identify the function of UUC UUC is a sense codon that specifies phenylalanine in the standard genetic code. During translation it is read by an appropriate tRNA carrying phenylalanine, allowing that amino acid to be incorporated into the growing polypeptide. It therefore conveys amino-acid information rather than a stop signal. UUU also specifies phenylalanine, illustrating that more than one codon can specify the same amino acid.

Step 3: Conclusion UUC codes for phenylalanine and is not a terminator codon. Hence, the correct option is (C).

Quick Tip to Solve: Memorise the complete stop set UAA, UAG and UGA; then check the word not before choosing any other codon.

8. Select the correct statements regarding Hardy-Weinberg principle.

(A) Sum total of all the allelic frequencies is 1.

(B) Genetic drift affect Hardy-Weinberg principle.

(C) Allele frequencies in a population are stable and is constant from generation to generation.

(D) The gene pool continues changing generation after generation.

Choose the correct answer from the options given below: [5 marks]

(A) (B) and (D) only

(B) (A), (B) and (C) only

(C) (A) and (D) only

(D) (B) and (C) only

Correct Answer: (B) (A), (B) and (C) only

Solution:

Concept:

- The Hardy-Weinberg principle states that allele frequencies remain constant across generations in an ideal population unless an evolutionary force disturbs the equilibrium.
- For two alleles with frequencies p and q, the total allele frequency is $p + q = 1$. Their genotype frequencies satisfy $p^2 + 2pq + q^2 = 1$.

Step 1: Test the frequency statements Statement (A) is correct because all the alleles at a given locus together constitute the whole allele pool, so their frequencies sum to one. Statement (C) is also correct: stability of allele frequencies from generation to generation is the defining prediction of Hardy-Weinberg equilibrium. This describes an ideal population in the absence of disturbing evolutionary forces; it does not assert that every real population necessarily remains unchanged.

Step 2: Identify the effect of genetic drift Statement (B) is correct because genetic drift changes allele frequencies through random sampling, particularly in small populations. It therefore disturbs Hardy-Weinberg equilibrium. Mutation, migration, genetic recombination and natural selection can also disturb the equilibrium. The statement concerns a factor affecting the principle's equilibrium conditions, rather than a condition required for maintaining them.

Step 3: Reject the changing gene-pool statement Statement (D) contradicts equilibrium: a gene pool that continues changing does not retain constant allele frequencies. Thus the correct set contains the first three statements and excludes the fourth. The first and third options include the false statement about a continually changing gene pool. The fourth option omits the true statement that the total allele frequency equals one, so it is incomplete.

Step 4: Conclusion The first three statements are correct, whereas the statement about a continually

changing gene pool is false. Hence, the correct option is (B).

Quick Tip to Solve: Separate the equilibrium prediction from the forces that disturb it: constant allele frequencies define equilibrium, while genetic drift changes those frequencies.

9. Identify the agencies which are involved in developing the technology of biogas production.

(A) Khadi and Village Industries Commission

(B) Indian Farmers Welfare Association

(C) Indian Biogas Production Institute

(D) Indian Agricultural Research Institute

Choose the correct answer from the options given below: [5 marks]

(A) (A), (B) and (D) only

(B) (B), (C) and (D) only

(C) (A) and (D) only

(D) (B) and (C) only

Correct Answer: (C) (A) and (D) only

Solution:

Concept:

- Biogas is a fuel mixture rich in methane, produced when methanogenic microbes act on organic wastes under anaerobic conditions.
- In India, the Indian Agricultural Research Institute (IARI) and the Khadi and Village Industries Commission (KVIC) have developed technology for biogas production.

Step 1: Identify the two relevant agencies Statement (A) names the Khadi and Village Industries Commission, or KVIC. This is one of the agencies associated with developing biogas technology in India. Statement (D) names the Indian Agricultural Research Institute, or IARI. This is the other agency identified in the NCERT account. Hence both (A) and (D) must occur in the selected combination.

Step 2: Reject the unsupported combinations Statement (B), Indian Farmers Welfare Association, and statement (C), Indian Biogas Production Institute, are not the two agencies specified for this development. Option (A) includes (B), so it adds an incorrect agency. Option (B) includes both (B) and (C), while omitting (A). Option (D) selects (B) and (C) and excludes both required agencies. Only option (C) contains exactly the pair (A) and (D).

Step 3: Conclusion The agencies are the Khadi and Village Industries Commission and the Indian Agricultural Research Institute only. Hence, the correct option is (C).

Quick Tip to Solve: Remember the Indian biogas-technology pair as KVIC plus IARI; do not select an agency merely because its name contains biogas.

10. Identify the bacteria which can fix atmospheric nitrogen and are free-living in the soil.

(A) ***Azotobacter***

(B) ***Rhizobium***

(C) ***Azospirillum***

(D) ***Anabaena***

Choose the correct answer from the options given below: [5 marks]

(A) (A) and (C) only

(B) (B) and (D) only

(C) (B), (C) and (D) only

(D) (A), (B) and (C) only

Correct Answer: (A) (A) and (C) only

Solution:

Concept:

- Biological nitrogen fixation converts atmospheric nitrogen into forms available to living organisms through nitrogen-fixing microorganisms.
- NCERT identifies free-living soil bacteria such as *Azotobacter* and *Azospirillum*; *Rhizobium* fixes nitrogen in symbiotic association with leguminous roots.

Step 1: Select the free-living soil bacteria Statement (A), *Azotobacter*, names a free-living nitrogen-fixing soil bacterium. Statement (C), *Azospirillum*, is also included among free-living nitrogen-fixing bacteria in the NCERT account of biofertilisers. These two organisms satisfy the description asked for, so the required combination is (A) and (C).

Step 2: Distinguish the other nitrogen fixers *Rhizobium*, statement (B), is the familiar symbiotic nitrogen fixer of legume root nodules; it is not the free-living category required here. *Anabaena*, statement (D), is a nitrogen-fixing cyanobacterium, discussed separately among cyanobacterial biofertilisers. The question targets the named free-living soil bacterial pair. Options (B), (C), and (D) each include *Rhizobium*, or the wrong grouping, whereas option (A) gives exactly *Azotobacter* and *Azospirillum*.

Step 3: Conclusion The required organisms are *Azotobacter* and *Azospirillum* only. Hence, the correct option is (A).

Quick Tip to Solve: First separate free-living soil bacteria from the legume symbiont Rhizobium and the cyanobacterial biofertilisers.

11. Arrange the following steps involved in PCR in the correct sequence.

(A) Amplification

(B) Extension of primers

(C) Primer annealing

(D) Denaturation

Choose the correct answer from the options given below: [5 marks]

(A) (C), (B), (A), (D)

(B) (D), (B), (A), (C)

(C) (B), (A), (D), (C)

(D) (D), (C), (B), (A)

Correct Answer: (D) (D), (C), (B), (A)

Solution:

Concept:

- Polymerase chain reaction (PCR) increases the amount of a selected DNA segment by repeated cycles using a template, two primers, nucleotides and a thermostable DNA polymerase.
- Each cycle separates the template strands, allows primers to bind, and extends those primers; repetition of the cycle produces amplification.

Step 1: Order the events within one PCR cycle Denaturation, statement (D), comes first: heating separates the two DNA strands by disrupting hydrogen bonds. On cooling, the primers anneal to complementary sites on the templates; this is statement (C). Only after a primer has bound can the polymerase extend its free end and synthesise the complementary DNA strand. Primer extension is statement (B). Thus the physical order within the cycle is (D), (C), (B).

Step 2: Place amplification after the synthesis steps Repeated cycles of denaturation, annealing and extension make additional copies of the chosen region. Amplification, statement (A), is therefore the resulting increase in DNA after these events, rather than the event that opens a cycle. The complete sequence listed in the question is (D), (C), (B), (A). Option (A) starts with annealing before strand separation; option (B) places extension before annealing; option (C) begins with extension and puts denaturation later. None can represent the required PCR order.

Step 3: Conclusion The correct sequence is denaturation, primer annealing, extension of primers, and amplification. Hence, the correct option is (D).

Quick Tip to Solve: Use the PCR order separate, bind, extend; repeated cycles of those three operations amplify the target DNA.

12. Which one of the following microorganisms is used as a cloning vector to deliver the genes of interest into a variety of plants? [5 marks]

(A) *Bacillus thuringiensis*

(B) Rhino viruses

(C) *Agrobacterium tumifaciens*

(D) Nucleopolyhedrovirus

Correct Answer: (C) *Agrobacterium tumifaciens*

Solution:

Concept:

- A cloning vector carries a gene of interest into a host cell; successful plant transformation requires an effective system for delivering DNA into plant cells.
- The Ti plasmid of *Agrobacterium tumefaciens* naturally transfers a DNA segment into plants and is modified into a disarmed vector for useful gene transfer.

Step 1: Connect natural gene transfer with the vector *Agrobacterium tumefaciens* is a soil bacterium able to transfer T-DNA from its Ti plasmid into plant cells. In nature this process is associated with crown-gall disease. Biotechnology exploits the transfer machinery while removing or disabling the tumour-inducing genes. A desired gene can then be carried into a variety of plant cells without retaining the disease-causing effect. This identifies the organism named in option (C).

Step 2: Distinguish the other microorganisms *Bacillus thuringiensis*, option (A), is known for insecticidal proteins and supplies the cry genes used in Bt crops; it is not the standard bacterium used to deliver the gene into those plants. Rhinoviruses, option (B), infect humans and are not plant cloning vectors. Nucleopolyhedroviruses, option (D), are used as highly specific biological control agents against insects, rather than as the familiar plant gene-transfer system. The delivery role described therefore belongs to Agrobacterium and its modified Ti plasmid.

Step 3: Conclusion The microorganism is *Agrobacterium tumefaciens*, whose modified Ti plasmid delivers genes of interest into plants. Hence, the correct option is (C).

Quick Tip to Solve: Associate Agrobacterium with plant DNA delivery and Bt with insecticidal cry genes; the donor of a useful gene need not be its delivery vector.

13. Which one of the following organisms has been disarmed and used to deliver desirable genes into animal cells? [5 marks]

(A) Retroviruses

(B) Cyanobacteria

(C) Yeast

(D) Baculoviruses

Correct Answer: (A) Retroviruses

Solution:

Concept:

- A vector carries a desirable gene into a host cell. A useful vector must deliver the gene while avoiding the disease-producing effects of its natural form.
- Retroviruses infect animal cells and can introduce genetic material into them. Disarming a virus removes or disables its harmful functions while retaining the features needed for gene delivery.

Step 1: Identify the vector suited to animal cells The question asks specifically about an organism that has been disarmed for delivering desirable genes into animal cells. Retroviruses naturally enter animal cells and have genetic machinery that enables their genetic material to be incorporated into the host genome. This property makes them suitable starting material for engineered gene-delivery vectors. After the disease-causing functions have been removed, the modified viral vector can carry the desired genetic material into the animal cell.

Step 2: Distinguish the other organisms Cyanobacteria are photosynthetic prokaryotes; they are not the disarmed animal-cell gene-delivery vectors described here. Yeast is widely used as a eukaryotic host in biotechnology, but being a host for recombinant DNA is different from being the disarmed viral vector that transfers genes into animal cells. Baculoviruses are associated with insects and other arthropods and are well known in biological pest control. The NCERT example of viruses disarmed to deliver desirable genes into animal cells is retroviruses. Therefore, the general association of baculoviruses with insects does not replace the specific vector named in the question.

Step 3: Conclusion Retroviruses have been disarmed and used to deliver desirable genes into animal cells. Hence, the correct option is (A).

Quick Tip to Solve: Link disarmed retroviruses with animal-cell gene delivery; distinguish a gene-delivery vector from a host used to grow recombinant DNA.

14. Arrange the following steps which are involved in action of Bt toxin proteins on insects in correct sequence.

(A) Conversion of inactive toxin into active one by alkaline pH of the gut of insect

(B) Creation of pores that cause cell swelling and lysis which leads to death of insect

(C) Inactive protoxins is ingested by insect

(D) Activated toxin binds to the surface of midgut epithelial cells of insect

Choose the correct answer from the options given below: [5 marks]

(A) (A), (D), (C), (B)

(B) (D), (B), (C), (A)

(C) (C), (A), (D), (B)

(D) (C), (B), (A), (D)

Correct Answer: (C) (C), (A), (D), (B)

Solution:

Concept:

- *Bacillus thuringiensis* produces insecticidal proteins as inactive protoxins. Activation occurs in the alkaline gut of a susceptible insect after ingestion.
- Activated toxin binds to receptors on midgut epithelial cells, forms pores and disrupts the cells, ultimately killing the insect.

Step 1: Begin with ingestion and activation The insect must first ingest the inactive protoxin, so the event labelled (C) comes first. The toxin cannot act on the gut lining before entering the gut. The alkaline conditions of the insect gut then convert the inactive toxin to its active form, corresponding to event (A). This also explains why the bacterium is not killed by its own toxin: the protein is initially produced in an inactive form rather than acting directly on the producer.

Step 2: Place receptor binding before pore formation After activation, the toxin binds to the surface of the insect's midgut epithelial cells, event (D). Binding positions the toxin at its target membrane. Pore creation follows this binding, event (B). The pores disturb membrane integrity and ion and water balance, causing swelling and lysis of the cells and finally the death of the susceptible insect.

Step 3: Compare the complete sequences The required sequence is ingestion, activation, receptor binding and pore formation, or $C \rightarrow A \rightarrow D \rightarrow B$. The first option places activation before ingestion. The second begins with binding before either ingestion or activation. The fourth places pore formation immediately after ingestion, before activation and binding. Only the third option preserves every necessary causal step.

Step 4: Conclusion Ingestion is followed by activation, midgut-cell binding and pore formation with cell lysis. Hence, the correct option is (C).

Quick Tip to Solve: Remember the causal chain: eat the protoxin, activate it in the alkaline gut, bind the target cell, then make pores. Binding must precede membrane damage.

15. Which one of the following techniques serve the purpose of early diagnosis of diseases? [5 marks]

(A) Stool analysis

(B) Enzyme linked immuno-sorbent assay

(C) Urine analysis

(D) Serum analysis

Correct Answer: (B) Enzyme linked immuno-sorbent assay

Solution:

Concept:

- Early diagnosis detects a disease-associated molecule or immune response before conventional symptoms and routine examination establish the disease clearly.
- Enzyme-linked immunosorbent assay (ELISA) is based on the specificity of antigen-antibody interaction. An enzyme-linked detection system produces a measurable signal when the relevant antigen or antibody is present.

Step 1: Relate ELISA to early detection In an ELISA test, a specific antigen or antibody is recognised through binding to its corresponding partner. Depending on the test format, the assay can detect an antigen produced by the pathogen or antibodies produced against it. An enzyme attached to a detection reagent acts on a substrate to produce a detectable signal. This molecular recognition makes ELISA useful for diagnosing infections and other conditions without relying solely on visible symptoms. It is therefore one of the standard techniques cited for early diagnosis of disease.

Step 2: Compare the remaining choices Stool analysis and urine analysis examine particular specimens and can reveal disease-related abnormalities, but neither name identifies the specific antigen-antibody technique tested in this question. Serum analysis similarly describes analysis of a specimen rather than a particular sensitive immunological assay. Indeed, an ELISA may itself use a serum sample, but the diagnostic principle and method are still ELISA. The question asks which named technique serves early diagnosis in the biotechnology context, so the precise technique is enzyme-linked immunosorbent assay rather than the broad categories of specimen analysis.

Step 3: Conclusion Enzyme-linked immunosorbent assay (ELISA) is the technique used for early diagnosis through specific antigen-antibody detection. Hence, the correct option is (B).

Quick Tip to Solve: For an early-diagnosis question, identify the molecular detection method: ELISA uses antigen-antibody specificity, whereas specimen names alone do not define the assay.

16. When the pistils are fused together, this state is called: [5 marks]

(A) Apocarpous

(B) Syncarpous

(C) Monocarpellary

(D) Multicarpellary

Correct Answer: (B) Syncarpous

Solution:

Concept:

- The gynoecium is the female reproductive whorl of a flower. Its carpels may remain free or become fused, and this relationship determines whether the condition is apocarpous or syncarpous.
- Apocarpous describes free carpels, whereas syncarpous describes fused carpels. Monocarpellary and multicarpellary describe the number of carpels rather than whether they are fused.

Step 1: Identify the relationship stated in the question The decisive phrase is "fused together". It describes union among the female reproductive units rather than simply stating how many are present. In a syncarpous gynoecium, two or more carpels are united and form a compound pistil. Mustard and tomato are familiar examples used to illustrate this condition. Thus the botanical term associated with fusion is syncarpous. The question's wording about fused pistils points to this standard classification of the gynoecium by the relationship among its carpels.

Step 2: Separate fusion from carpel number Apocarpous is the opposite condition: the carpels remain free, as in lotus and rose, so it cannot describe fusion. Monocarpellary means that the gynoecium has a single carpel; it does not name a condition in which several carpels are united. Multicarpellary means that more than one carpel is present. A multicarpellary gynoecium may have free carpels or fused carpels, so that term alone does not specify the fusion stated in the question. Only syncarpous provides both the relevant structural relationship and the accepted botanical terminology.

Step 3: Conclusion The condition in which the carpels are fused together is called syncarpous. Hence, the correct option is (B).

Quick Tip to Solve: Use "syn" to recall union: syncarpous means fused carpels. Count-based terms such as multicarpellary do not tell you whether fusion occurs.

17. Pollination is not carried out by water in - [5 marks]

(A) *Zostera*

(B) Water lily

(C) *Hydrilla*

(D) *Vallisneria*

Correct Answer: (B) Water lily

Solution:

Concept:

- Pollination is the transfer of pollen from the anther to the stigma. Its agent is identified by how the pollen travels, rather than simply by whether the plant lives in water.
- Hydrophily means pollination by water. Many aquatic flowering plants nevertheless expose their flowers above water and use insects or wind instead.

Step 1: Identify the exception Water lily is an aquatic plant, but its flowers emerge above the water surface. Insects visit these flowers and carry pollen between their reproductive parts. Therefore, water is its habitat but is not its pollinating agent.

Step 2: Check the remaining plants *Zostera* is a marine seagrass in which pollen is transported through water. *Vallisneria* is the familiar example of pollination at the water surface: male flowers reach the surface and meet the female flowers. *Hydrilla* is also included among the water-pollinated aquatic plants in this comparison. Thus, these three do not provide the exception asked for.

Step 3: Conclusion Pollination is not carried out by water in water lily. Hence, the correct option is (B).

Quick Tip to Solve: Distinguish an aquatic habitat from hydrophily: water lily has emergent flowers and insect pollination.

18. Identify the structures which have the potency to give rise to all the tissues and organs. [5 marks]

(A) Stem cells

(B) Trophoblast

(C) Chorionic villi

(D) Placenta

Correct Answer: (A) Stem cells

Solution:

Concept:

- Stem cells are undifferentiated cells with the ability to divide and differentiate into specialised cell types. Embryonic stem cells have broad developmental potential.
- In the blastocyst, the inner cell mass gives rise to the embryo, whereas the surrounding trophoblast chiefly contributes to implantation and extraembryonic structures.

Step 1: Identify the developmental cell population The structures described must be capable of

generating the different tissues and organs of the developing body. Embryonic stem cells, associated with the inner cell mass, possess this broad differentiation capacity. Stem cells are therefore the appropriate choice among the listed structures.

Step 2: Distinguish the supporting structures The trophoblast forms the outer cell layer of the blastocyst and helps establish attachment to the uterine endometrium. Chorionic villi provide a large surface for exchange, and the placenta supports nutrient and gas exchange between mother and foetus. These specialised supporting structures are not the population that differentiates into all the organs of the embryo.

Step 3: Conclusion Stem cells have the developmental potency referred to in the question. Hence, the correct option is (A).

Quick Tip to Solve: Associate the inner cell mass and embryonic stem cells with the embryo proper; associate trophoblast and villi with support and exchange.

19. Which one of the following structures is not essential for maturation and motility of sperms?

[5 marks]

(A) Epididymis

(B) Cervix

(C) Seminal vesicle

(D) Prostate

Correct Answer: (B) Cervix

Solution:

Concept:

- Sperms are formed in the seminiferous tubules and undergo further maturation as they pass through the male reproductive tract, especially the epididymis.
- Secretions of the male accessory glands contribute to seminal plasma and help provide a suitable medium for sperm function. Female reproductive structures have different roles.

Step 1: Recognise the male structures The epididymis is involved in sperm maturation and the acquisition of functional competence. The seminal vesicles add secretion containing fructose, an energy source used by sperms. The prostate adds its secretion to seminal plasma and contributes to the environment in which sperm cells are transported. These structures belong to the male reproductive system and contribute to sperm function.

Step 2: Identify the structure with a different role The cervix is the narrow lower part of the uterus and opens into the vagina through the cervical canal. It belongs to the female reproductive tract; it is not a male duct or accessory gland responsible for sperm maturation or the provision of seminal plasma. Consequently, it is the exception among the four alternatives. This does not mean cervical conditions cannot affect sperm passage; it distinguishes their site of maturation and seminal support.

Step 3: Conclusion The cervix is not essential for the maturation and motility of sperms in the sense asked here. Hence, the correct option is (B).

Quick Tip to Solve: For this exception question, first separate the female cervix from the male epididymis and accessory glands.

20. Match List-I with List-II.

List-I (Contraceptive methods)	List-II (Examples)
(A) Non-medicated IUD	(I) Multiload 375
(B) Copper releasing IUD	(II) LNG-20
(C) Hormone releasing IUD	(III) Vaults
(D) Barrier method	(IV) Lippes loop

Choose the correct answer from the options given below: [5 marks]

(A) (A)-(III), (B)-(II), (C)-(I), (D)-(IV)

(B) (A)-(IV), (B)-(I), (C)-(III), (D)-(II)

(C) (A)-(I), (B)-(III), (C)-(IV), (D)-(II)

(D) (A)-(IV), (B)-(I), (C)-(II), (D)-(III)

Correct Answer: (D) (A)-(IV), (B)-(I), (C)-(II), (D)-(III)

Solution:

Concept:

- Intrauterine devices are classified as non-medicated, copper-releasing or hormone-releasing according to the material or substance responsible for their contraceptive action.
- Barrier methods physically prevent sperm entry or contact with the ovum. They are distinct from devices inserted inside the uterus.

Step 1: Match each contraceptive category Lippes loop is a non-medicated IUD, so (A) matches (IV). Multiload 375 is a copper-releasing IUD, so (B) matches (I). Copper ions reduce sperm motility and fertilising capacity, while IUDs also promote phagocytosis of sperms within the uterus.

Step 2: Complete and verify the matching LNG-20 is a hormone-releasing IUD, so (C) matches (II). Its hormonal action helps make the uterus unsuitable for implantation and the cervix hostile to sperms. Vaults are barrier devices covering the cervix and preventing sperm entry, so (D) matches (III). The complete sequence is therefore IV, I, II, III. The first and third alternatives misclassify the non-medicated IUD, while the second interchanges the hormone-releasing example and the barrier example.

Step 3: Conclusion The correct matching sequence is IV, I, II, III for the four contraceptive methods respectively. Hence, the correct option is (D).

Quick Tip to Solve: Remember the three IUD anchors: Lippes loop is non-medicated, Multiload contains copper, and LNG releases hormone.

21. Which one of the following diseases is completely curable if detected early and treated properly? [5 marks]

(A) Hepatitis-B

(B) Gonorrhoea

(C) Genital herpes

(D) HIV

Correct Answer: (B) Gonorrhoea

Solution:

Concept:

- Gonorrhoea is a bacterial sexually transmitted infection caused by the gonococcus, *Neisseria gonorrhoeae*.
- Early detection and proper treatment can eliminate a curable bacterial infection; viral infections in this list are distinguished from it.

Step 1: Identify the curable infection Gonorrhoea is the bacterial disease among the four choices. In the NCERT classification, gonorrhoea and other treatable sexually transmitted infections can be completely cured when detected early and treated properly. Therefore it satisfies both conditions in the question: early diagnosis and appropriate treatment.

Step 2: Eliminate the viral alternatives Hepatitis-B is caused by hepatitis B virus, genital herpes by herpes simplex virus, and HIV infection by human immunodeficiency virus. These are the exceptions NCERT lists to the general curability of sexually transmitted infections. Controlling their symptoms or viral activity is different from completely eliminating the infection; hence none is the intended answer.

Step 3: Conclusion Gonorrhoea is completely curable if detected early and treated properly. Hence, the correct option is (B).

Quick Tip to Solve: For the NCERT exception list, remember hepatitis-B, genital herpes and HIV; gonorrhoea is the bacterial, curable choice.

22. "Two closely related species competing for the same resources cannot co-exist indefinitely and the competitively inferior one will be eliminated eventually." This statement was given by: [5 marks]

(A) Malthus theory of population growth

(B) Gause's competitive exclusion principle

(C) Verhulst-Pearl logistic growth

(D) Darwin's theory of natural selection

Correct Answer: (B) Gause's competitive exclusion principle

Solution:

Concept:

- Interspecific competition occurs when different species depend on the same limiting resource.
- Gause's competitive exclusion principle states that complete competitors cannot coexist indefinitely

under competition for the same limiting resources.

Step 1: Recognise the diagnostic statement The statement describes two species using the same resources and predicts eventual elimination of the competitively inferior species. These features identify competitive exclusion: the inferior competitor cannot sustain itself indefinitely when the superior competitor gains the limiting resource.

Step 2: Distinguish the other theories Malthus discussed population increase and the limitation imposed by resources. The Verhulst-Pearl logistic model describes population growth as it approaches carrying capacity. Darwin's natural selection concerns differential survival and reproduction and consequent evolutionary change. Although competition can contribute to natural selection, the precise ecological statement quoted here is Gause's principle, not the name of any of these other theories.

Step 3: Conclusion The statement expresses Gause's competitive exclusion principle. Hence, the correct option is (B).

Quick Tip to Solve: Look for the combination of identical limiting resources and elimination of the inferior competitor: it identifies competitive exclusion.

23. The trophic level that has a certain mass of living material at a particular time is called as:

[5 marks]

(A) Standing crop

(B) Productivity

(C) Stratification

(D) Respiration loss

Correct Answer: (A) Standing crop

Solution:

Concept:

- Standing crop is the amount of living material present in a trophic level at a particular time.
- It may be measured as biomass or as the number of organisms per unit area; biomass and productivity describe different quantities.

Step 1: Identify the quantity being measured The words "mass of living material" and "at a particular time" describe an existing stock of organisms. In ecosystem terminology, the stock at a trophic level is its standing crop. For example, the living biomass of herbivores measured on one sampling date is their standing crop, irrespective of the rate at which new biomass is being produced.

Step 2: Reject quantities with different meanings Productivity is a rate of biomass or organic matter production and therefore includes a time interval in its units. Stratification is the vertical arrangement of organisms into layers, such as trees, shrubs and herbs in a forest. Respiration loss is the energy or organic matter used in respiration, not the living mass present. These definitions do not match the stock specified in the question.

Step 3: Conclusion The living mass present at a trophic level at a given time is the standing crop. Hence, the correct option is (A).

Quick Tip to Solve: Treat standing crop as a snapshot of living biomass; treat productivity as the rate at which biomass is produced.

24. Match List-I with List-II.

List-I (Sacred Groves)	List-II (States)
(A) Khasi and Jaintia Hills	(I) Rajasthan
(B) Western Ghat regions	(II) Karnataka and Maharashtra
(C) Sarguja and Bastar areas	(III) Madhya Pradesh
(D) Aravalli Hills	(IV) Meghalaya

Choose the correct answer from the options given below: [5 marks]

(A) (A)-(III), (B)-(II), (C)-(I), (D)-(IV)

(B) (A)-(I), (B)-(IV), (C)-(III), (D)-(II)

(C) (A)-(II), (B)-(I), (C)-(IV), (D)-(III)

(D) (A)-(IV), (B)-(II), (C)-(III), (D)-(I)

Correct Answer: (D) (A)-(IV), (B)-(II), (C)-(III), (D)-(I)

Solution:

Concept:

- Sacred groves are forest patches protected by local communities because of religious and cultural traditions.
- NCERT examples link the Khasi and Jaintia Hills with Meghalaya, the Western Ghats with Karnataka and Maharashtra, Sarguja and Bastar with Madhya Pradesh in the stated list, and the Aravallis with Rajasthan.

Step 1: Match the hill regions Khasi and Jaintia Hills correspond to Meghalaya, so List-I entry (A) matches List-II entry (IV). The Western Ghat regions named in this question correspond to Karnataka and Maharashtra, so (B) matches (II). These two matches already distinguish the correct code from most of the alternatives.

Step 2: Complete and check the code Using the locations and state names supplied in the question, Sarguja and Bastar areas match Madhya Pradesh, giving (C)-(III), and Aravalli Hills match Rajasthan, giving (D)-(I). The complete sequence is therefore (A)-(IV), (B)-(II), (C)-(III), (D)-(I). Only the fourth option contains all four pairs. The first three options misplace Khasi and Jaintia Hills, and they also fail at least one of the remaining location pairs.

Step 3: Conclusion The matching sequence is IV, II, III, I for the four listed groves respectively. Hence, the correct option is (D).

Quick Tip to Solve: Anchor Khasi-Jaintia to Meghalaya and Aravalli to Rajasthan, then verify the remaining two pairs against the supplied list.

25. Arrange the following steps involved in the regulation of gene expression in correct sequence.

(A) Processing level

(B) Translational level

(C) Transcriptional level

(D) Transport of mRNA from the nucleus to the cytoplasm

Choose the correct answer from the options given below: [5 marks]

(A) (B), (A), (D), (C)

(B) (D), (B), (A), (C)

(C) (C), (A), (D), (B)

(D) (A), (D), (B), (C)

Correct Answer: (C) (C), (A), (D), (B)

Solution:

Concept:

- Eukaryotic gene expression proceeds from DNA transcription to RNA processing, RNA export and finally protein synthesis. Regulation can act at each of these levels.
- A later stage requires the product of the preceding stage: the primary transcript must be made before it can be processed, and mature mRNA must reach the cytoplasm before translation.

Step 1: Begin with transcription and processing The transcriptional level determines whether and how much primary RNA transcript is produced from a gene. This must come first, since without an RNA transcript there is no substrate for the later stages. Next comes the processing level: in a eukaryotic cell the primary transcript undergoes modifications such as splicing, capping and polyadenylation to form mature mRNA. Thus the first two listed stages are transcriptional level followed by processing level.

Step 2: Place export before translation Mature mRNA is transported from the nucleus to the cytoplasm, where ribosomes translate its coding sequence into a polypeptide. Transport therefore follows processing and precedes the translational level. The full sequence is transcription, processing, mRNA transport and translation. A sequence beginning with translation places protein synthesis before its mRNA is available, while one beginning with transport or processing omits the necessary initial transcription. Only the third printed sequence follows the cellular order throughout.

Step 3: Conclusion The correct order is transcriptional level, processing level, transport of mRNA to the cytoplasm, and translational level. Hence, the correct option is (C).

Quick Tip to Solve: Follow the molecule: DNA makes primary RNA, processing makes mature mRNA, export delivers it, and ribosomes translate it.

26. Identify the organism whose genome has not been sequenced. [5 marks]

(A) *Caenorhabditis elegans*

(B) *Arabidopsis*

(C) *Drosophila*

(D) Sea urchin

Correct Answer: (D) Sea urchin

Solution:

Concept:

- Genome sequencing determines the order of nucleotide bases in an organism's DNA. The familiar textbook examples of sequenced eukaryotes include a nematode, a flowering plant and a fruit fly.
- A historical list of completed genomes must be distinguished from a timeless claim that a particular organism has never had its genome sequenced.

Step 1: Identify the three standard examples The nematode *Caenorhabditis elegans*, the plant *Arabidopsis* and the fruit fly *Drosophila* are standard examples of organisms whose genomes have been sequenced. Therefore options (A), (B) and (C) cannot serve as the exception in the textbook comparison tested here. Their different body plans do not prevent sequencing: the relevant property is the determination of their DNA sequence, rather than the complexity of the organism.

Step 2: Distinguish the keyed answer from the literal claim Sea urchin is the remaining organism and is the answer intended by this textbook-style list. However, this is an outdated exclusion. The Sea Urchin Genome Sequencing Consortium published the genome of the purple sea urchin, *Strongylocentrotus purpuratus*, in *Science* in 2006 (volume 314, pages 941–952). Thus, by the date of this paper, sea urchin also has a sequenced representative. Without an explicitly stated historical cutoff, the question has no scientifically valid unique exception among the four names. This does not change which response the supplied examination key accepts.

Step 3: Conclusion Sea urchin is the intended textbook and keyed response. Hence, the correct option is (D) under that intended comparison. Taken literally as a present-day claim, the question is outdated and has no valid unique answer because a sea urchin genome was published in 2006.

Quick Tip to Solve: Remember worm, plant and fly as standard textbook genome examples, but check the historical cutoff before treating any older list as exhaustive.

27. Which one of the following statements is the correct fact about human genome project? [5 marks]

(A) The average gene consists of 30000 bases.

(B) The functions are unknown for less than 20 percent of the discovered genes.

(C) Less than 2 percent of the genome codes for proteins.

(D) Chromosome Y has the most genes (2968), and 1 has the fewest (231).

Correct Answer: (C) Less than 2 percent of the genome codes for proteins.

Solution:

Concept:

- The Human Genome Project determined the nucleotide sequence of human DNA and catalogued genes. The amount of DNA in a genome is different from the fraction that directly codes for proteins.
- In the textbook summary of the project, less than two percent of the human genome codes for proteins. Many other sequences occur in introns, regulatory regions and repetitive DNA.

Step 1: Check the protein-coding fraction Option (C) correctly states that less than 2 percent of the genome codes for proteins. A very large genome does not imply that most bases specify amino acids. Protein-coding sequences form only a small fraction of the total, and the remainder includes numerous non-protein-coding sequences. This distinction is one of the major conclusions highlighted in the Human Genome Project summary.

Step 2: Compare the remaining numerical statements Option (A) changes the textbook average gene length from about 3000 bases to 30000 bases, so it is incorrect. Option (B) also reverses the reported extent of uncertainty: the textbook account states that functions were unknown for over 50 percent of the discovered genes, rather than for less than 20 percent. These are historical project findings, so their figures should be read in that context rather than replaced with later estimates.

Step 3: Check the chromosome comparison Option (D) swaps the chromosome names. In the quoted project summary, chromosome 1 has the most genes, 2968, while chromosome Y has the fewest, 231. The option attaches the larger count to Y and the smaller count to chromosome 1, making both assignments wrong. Only the statement about the small protein-coding fraction remains correct among the four alternatives.

Step 4: Conclusion Less than 2 percent of the human genome codes for proteins. Hence, the correct option is (C).

Quick Tip to Solve: Link the textbook HGP facts as a set: about 3000 bases per average gene, under 2 percent protein-coding DNA, most genes on chromosome 1 and fewest on Y.

28. Arrange the following stages of human evolution in correct chronological order.

(A) ***Australopithecines***

(B) ***Homo erectus***

(C) ***Ramapithecus***

(D) ***Homo sapiens***

Choose the correct answer from the options given below: [5 marks]

(A) (C), (A), (B), (D)

(B) (A), (C), (B), (D)

(C) (D), (A), (B), (C)

(D) (C), (D), (A), (B)

Correct Answer: (A) (C), (A), (B), (D)

Solution:

Concept:

- A chronological sequence places the earliest forms first and the most recent forms last. The NCERT account describes successive fossil forms using their approximate geological ages.
- In that account, *Ramapithecus* predates the australopithecines, followed by *Homo erectus* and then modern *Homo sapiens*.

Step 1: Identify the earlier fossil forms The textbook places *Ramapithecus* among primates described from about 15 million years ago. The australopithecines are described much later in the human-evolution account, around the African grassland stage. Therefore *Ramapithecus* must precede *Australopithecines* in the requested chronology. This is the order of the forms in the textbook narrative; it does not require treating every named form as a proven direct ancestor of the next.

Step 2: Place the later Homo forms *Homo erectus*, described from about 1.5 million years ago, comes after the australopithecines. Modern *Homo sapiens* comes later still and is therefore last among the four forms given. Combining these comparisons gives *Ramapithecus*, *Australopithecines*, *Homo erectus*, *Homo sapiens*. The second option reverses the first two forms, the third places modern humans first, and the fourth puts modern humans ahead of the australopithecines and *Homo erectus*; each contradicts the chronological order.

Step 3: Conclusion The chronological order is *Ramapithecus*, *Australopithecines*, *Homo erectus*, and *Homo sapiens*. Hence, the correct option is (A).

Quick Tip to Solve: Anchor the two ends first: Ramapithecus is earliest in this list, and modern Homo sapiens is latest.

29. Which one of the given terms states that mutations caused speciation? [5 marks]

(A) Variation

(B) Genetic recombination

(C) Gene migration

(D) Saltation

Correct Answer: (D) Saltation

Solution:

Concept:

- Saltation means a sudden, large evolutionary change. Hugo de Vries used the term for speciation arising through mutations, in contrast to slow accumulation of small variations.
- A mutation is a heritable change in genetic material. The question asks for the named evolutionary proposal connecting such changes with the origin of species, rather than for every process that can alter a population.

Step 1: Identify the theory described The decisive phrase is that mutations caused speciation. In the mutation theory associated with Hugo de Vries, new species could arise through a sudden major change rather than through many small, gradual changes. This single-step large mutation was called saltation. Thus the requested word names the proposed mode of evolutionary change.

Step 2: Distinguish the other processes Variation is the general term for differences among individuals; it does not specifically name sudden speciation by mutation. Genetic recombination reshuffles existing genetic material during sexual reproduction and produces new combinations of alleles. Gene migration, or gene flow, transfers alleles between populations when individuals or their gametes move. Recombination and migration can change genetic composition, but neither term states the mutation-based, sudden origin of a species. The specific historical term among the four choices is therefore saltation.

Step 3: Conclusion Saltation is the term used for the sudden evolutionary change by which mutations were proposed to cause speciation. Hence, the correct option is (D).

Quick Tip to Solve: Associate de Vries with mutation theory and saltation; distinguish a sudden evolutionary leap from the broad term variation.

30. Match List-I with List-II.

List-I (Biocontrol agents)	List-II (Affected organisms)
(A) Ladybird	(I) Mosquitoes
(B) *Bacillus thuringiensis*	(II) Aphids
(C) Dragonflies	(III) Plant pathogens
(D) *Trichoderma*	(IV) Caterpillars

Choose the correct answer from the options given below: [5 marks]

(A) (A)-(III), (B)-(II), (C)-(IV), (D)-(I)

(B) (A)-(IV), (B)-(II), (C)-(III), (D)-(I)

(C) (A)-(II), (B)-(IV), (C)-(I), (D)-(III)

(D) (A)-(I), (B)-(III), (C)-(II), (D)-(IV)

Correct Answer: (C) (A)-(II), (B)-(IV), (C)-(I), (D)-(III)

Solution:

Concept:

- Biological control uses living organisms or their products to reduce pest and pathogen populations, helping reduce dependence on chemical pesticides.
- Predators, bacterial insect pathogens and antagonistic fungi act on different targets. Match each agent to its characteristic target before comparing the combined codes.

Step 1: Match the insect predators Ladybirds feed on aphids, so List-I (A) matches List-II (II). Dragonflies help control mosquitoes, giving (C)-(I). These two predator-prey associations already separate the correct code from options that wrongly associate ladybirds with plant pathogens or caterpillars. Biological control depends on the feeding relationship, not merely on placing two insects together.

Step 2: Match the microbial agents The bacterium *Bacillus thuringiensis* is used to control caterpillars. Its insecticidal toxin acts in the susceptible larval gut, so (B)-(IV). Species of the fungus *Trichoderma* occur in the root ecosystem and are useful biological control agents against several plant pathogens, so (D)-(III). They are not the mosquito predators in this list.

Step 3: Check the combined code Collecting the four independently established matches gives (A)-(II), (B)-(IV), (C)-(I), (D)-(III). This is the third answer choice. The first, second and fourth choices all assign the ladybird to a target other than aphids; they also misplace other microbial or predator associations. Therefore none of those alternatives represents the complete set of correct relationships.

Step 4: Conclusion Ladybirds control aphids, Bt controls caterpillars, dragonflies control mosquitoes and Trichoderma controls plant pathogens. Hence, the correct option is (C).

Quick Tip to Solve: Fix the two predator pairs first: ladybird–aphid and dragonfly–mosquito. Then assign Bt to caterpillars and Trichoderma to pathogens.

31. Match List-I with List-II.

List-I (Applications)	List-II (Microorganisms)
(A) Immunosuppressive agent	(I) *Propionibacterium sharmanii*
(B) Blood-cholesterol lowering agents	(II) *Trichoderma polysporum*
(C) Nitrogen fixation	(III) *Monascus purpureus*
(D) Holes in 'Swiss cheese'	(IV) *Oscillatoria*

Choose the correct answer from the options given below: [5 marks]

(A) (A)-(III), (B)-(II), (C)-(I), (D)-(IV)

(B) (A)-(II), (B)-(III), (C)-(IV), (D)-(I)

(C) (A)-(IV), (B)-(II), (C)-(III), (D)-(I)

(D) (A)-(II), (B)-(IV), (C)-(I), (D)-(III)

Correct Answer: (B) (A)-(II), (B)-(III), (C)-(IV), (D)-(I)

Solution:

Concept:

- Microbes supply useful metabolites for medicine and food processing, while cyanobacteria can contribute biological nitrogen fixation.
- Use the product or biological activity as the identifying clue: cyclosporin A, statins, nitrogen fixation and carbon dioxide production correspond to different microorganisms.

Step 1: Identify the medical applications Cyclosporin A is an immunosuppressive agent obtained from *Trichoderma polysporum*. It suppresses immune responses and is used in organ transplantation; therefore (A)-(II). Statins produced by the yeast *Monascus purpureus* lower blood cholesterol by competitively inhibiting the enzyme involved in cholesterol synthesis. Thus the cholesterol-lowering application gives (B)-(III).

Step 2: Identify the agricultural and food applications *Oscillatoria* is a cyanobacterium included among the nitrogen-fixing organisms used to enrich soil, so (C)-(IV). Large holes in Swiss cheese result from the production of carbon dioxide by *Propionibacterium sharmanii*, giving (D)-(I). The holes are a consequence of gas formation during cheese processing, rather than an immunosuppressive or cholesterol-lowering action.

Step 3: Compare every code with the matches The combined sequence is (A)-(II), (B)-(III), (C)-(IV), (D)-(I), which is the second answer choice. The first and third choices fail at the immunosuppressive agent itself. The fourth begins with the correct immunosuppressive match but wrongly assigns cholesterol lowering to Oscillatoria, nitrogen fixation to Propionibacterium, and cheese holes to Monascus. Matching all four entries, rather than just one familiar pair, confirms the answer.

Step 4: Conclusion Trichoderma polysporum gives the immunosuppressant, Monascus gives statins, Oscillatoria fixes nitrogen, and Propionibacterium produces cheese holes. Hence, the correct option is (B).

Quick Tip to Solve: Remember the product chain: Trichoderma–cyclosporin, Monascus–statin, Oscillatoria–nitrogen fixation, Propionibacterium–cheese holes.

32. Select the correct methods to introduce the recombinant DNA into the host cells.

(A) Biolistics or gene gun for plant cells

(B) Micro-injection for an animal cell

(C) 'Disarmed pathogen' vectors

(D) By heating the host cell at 100°C and then cooling to 70°C

Choose the correct answer from the options given below: [5 marks]

(A) (A), (B) and (C) only

(B) (B) and (D) only

(C) (B), (C) and (D) only

(D) (A) and (C) only

Correct Answer: (A) (A), (B) and (C) only

Solution:

Concept:

- Recombinant DNA can enter host cells by direct physical delivery, such as biolistics or micro-injection, or by vectors whose disease-causing ability has been removed.
- The delivery method must preserve viable recipient cells. A controlled heat shock used for competent bacteria is very different from exposing cells to boiling temperature.

Step 1: Evaluate the three recognised delivery methods Statement (A) is correct: in biolistics, plant cells are bombarded with high-velocity gold or tungsten microparticles coated with DNA. Statement (B) is correct: micro-injection introduces recombinant DNA directly into an animal cell, commonly into its nucleus, through a fine needle. Statement (C) is also correct: disarmed pathogen vectors retain the ability to deliver DNA while their disease-causing properties are removed. A familiar plant example is a disarmed Ti-plasmid system derived from Agrobacterium.

Step 2: Reject the stated temperature treatment Statement (D) is incorrect. Heating host cells to 100°C and then cooling them to 70°C is not a standard transformation procedure and would severely damage or kill ordinary host cells. In the familiar bacterial competence procedure, cells are treated with suitable divalent cations, incubated with DNA on ice, briefly heat-shocked at about 42°C, and returned to ice. This controlled procedure must not be confused with boiling.

Step 3: Select the complete correct combination The true statements are (A), (B) and (C), while (D) is false. The first answer choice includes all three valid delivery methods and excludes the invalid high-temperature treatment. The choices containing (D) fail because they include a false method; the choice listing only (A) and (C) is incomplete because micro-injection is also valid.

Step 4: Conclusion Biolistics, micro-injection and disarmed pathogen vectors are valid delivery methods; the stated high-temperature treatment is invalid. Hence, the correct option is (A).

Quick Tip to Solve: For combination questions, mark each statement true or false first. Here the extreme 100-degree treatment eliminates every choice containing (D).

33. Arrange the following steps which are involved in the process of recombinant DNA technology in correct sequence.

(A) Fragmentation of DNA by restriction endonucleases

(B) Transferring the recombinant DNA into the host

(C) Ligation of desired DNA fragment into a vector

(D) Isolation of DNA

Choose the correct answer from the options given below: [5 marks]

(A) (A), (C), (B), (D)

(B) (B), (D), (C), (A)

(C) (C), (A), (D), (B)

(D) (D), (A), (C), (B)

Correct Answer: (D) (D), (A), (C), (B)

Solution:

Concept:

- Recombinant DNA technology joins a desired DNA fragment to a suitable vector and introduces the resulting DNA into a host cell.
- The operations have an essential dependency: DNA must first be available, then cut, then joined, and finally transferred.

Step 1: Place isolation and cutting first Isolation of DNA is step (D). The DNA has to be released from cells and purified before enzymes can be used to manipulate it. Restriction endonucleases then cut the isolated DNA at specific recognition sites. This fragmentation is step (A), and it supplies the desired fragment and the appropriately cut vector ends. Cutting cannot be placed before isolation because there would be no isolated DNA substrate available for the planned manipulation.

Step 2: Join the fragment before transfer DNA ligase joins the desired DNA fragment to the vector, producing recombinant DNA; this is step (C). Only after this recombinant construct has been formed can it be introduced into the host, as stated in step (B). Therefore the dependency chain is isolation, fragmentation, ligation and transfer. The complete sequence is (D), (A), (C), (B). The other sequences place transfer before formation of the recombinant molecule or place isolation after manipulation, so they do not describe the process correctly.

Step 3: Conclusion The sequence obtained by respecting these dependencies is the fourth listed sequence. Hence, the correct option is (D).

Quick Tip to Solve: For an rDNA sequence question, use the dependency chain: isolate, cut, join, then introduce into the host.

34. Identify the Bt toxin gene which controls the corn borer. [5 marks]

(A) *cryIAc*

(B) *cryIIAb*

(C) *cryIAb*

(D) *cryIIAc*

Correct Answer: (C) *cryIAb*

Solution:

Concept:

- Bacillus thuringiensis produces insecticidal crystal proteins encoded by cry genes. Different cry genes encode proteins active against different insect groups.
- The NCERT association for corn borer is cryIAb; cryIAc and cryIIAb are associated with control of cotton bollworms.

Step 1: Match the pest to its cry gene The question asks specifically about the corn borer. The relevant Bt toxin gene is cryIAb. Its name must be read completely: the Roman numeral and the final letters distinguish it from other cry genes. The fact that several options begin with cry does not make them interchangeable, since different toxin proteins have different insect specificities.

Step 2: Eliminate the other gene names The genes cryIAc and cryIIAb are the familiar NCERT pair used to control cotton bollworms. They are therefore not the requested corn-borer answer. The fourth option, cryIIAc, is also not the NCERT gene specified for this pest. Selecting cryIAb uses the particular gene-pest association rather than assuming that every Bt toxin controls every insect. In Bt crops, the introduced gene enables production of the corresponding toxin protein; the protein acts on susceptible insect larvae after ingestion and activation in their alkaline gut.

Step 3: Conclusion The Bt toxin gene that controls corn borer is *cryIAb*. Hence, the correct option is (C).

Quick Tip to Solve: Keep the two NCERT associations separate: cryIAc and cryIIAb for cotton bollworms; cryIAb for corn borer.

35. Select the incorrect statement about the insulin hormone produced by rDNA technique. [5 marks]

(A) Two DNA sequences corresponding to A and B chains of insulin were prepared and introduced in *E. coli*.

(B) Chains A and B were produced separately.

(C) Two chains were extracted and combined with C chain.

(D) In 1983, Eli Lilly, an American company, prepared the first human insulin.

Correct Answer: (C) Two chains were extracted and combined with C chain.

Solution:

Concept:

- Mature human insulin consists of two polypeptide chains, A and B, linked by disulphide bonds.
- The C peptide is present in the prohormone, proinsulin, but is removed during formation of mature

functional insulin.

Step 1: Recall the recombinant production method In the NCERT account, Eli Lilly prepared DNA sequences corresponding to the A and B chains of human insulin in 1983 and introduced them into E. coli. The two chains were produced separately, extracted, and combined by creating disulphide bonds. Thus the first two statements correctly describe production of the individual insulin chains. The company and year in the fourth statement also match that account.

Step 2: Identify the extra chain in the incorrect statement The third statement says that the extracted A and B chains were combined with a C chain. This is the error. The connecting C peptide is associated with proinsulin and is removed as proinsulin is processed into mature insulin. It is not added to the separately produced A and B chains to make the final active hormone. The required final product contains A and B chains joined through disulphide bonds. Because the question asks for the incorrect statement, select the statement that retains or adds C peptide rather than one of the correct production details.

Step 3: Conclusion The claim that A and B chains were combined with C chain is incorrect; mature insulin contains only A and B chains linked by disulphide bonds. Hence, the correct option is (C).

Quick Tip to Solve: Underline the word incorrect, then remember that C peptide belongs to proinsulin and is absent from mature insulin.

36. Intine of the pollen grain is made up of: [5 marks]

(A) Starch and agarose

(B) Heparin and lignin

(C) Cellulose and pectin

(D) Glycogen and collagen

Correct Answer: (C) Cellulose and pectin

Solution:

Concept:

- The pollen grain wall has an outer exine and an inner intine. These layers differ in both composition and function.
- The intine is a thin, continuous inner wall made of cellulose and pectin; the resistant outer exine contains sporopollenin.

Step 1: Identify the inner wall layer The question names the intine rather than the exine. The intine is the inner pollen wall and is composed of cellulose and pectin. These are characteristic plant cell-wall materials. The intine is thin and continuous, whereas the exine is the highly resistant outer layer, interrupted at germ pores where sporopollenin is absent. Keeping the names of the two wall layers distinct avoids confusing their chemical compositions.

Step 2: Check the alternatives against wall composition Cellulose and pectin is the only pair matching the intine. Starch is primarily a storage carbohydrate and agarose is obtained from algae; they are not the stated constituents of this pollen wall layer. Heparin and lignin do not form the intine: lignin is

associated with thickened supporting or conducting plant walls. Glycogen is a storage polysaccharide typical of animals and fungi, while collagen is an animal structural protein. None of those alternative pairs describes the inner wall of a pollen grain. Therefore the option listing cellulose and pectin is selected.

Step 3: Conclusion The intine of a pollen grain is made of cellulose and pectin. Hence, the correct option is (C).

Quick Tip to Solve: Associate intine with the ordinary plant-wall materials cellulose and pectin, and exine with resistant sporopollenin.

37. At maturity, a typical angiosperm embryo sac is: [5 marks]

(A) 6-nucleate and 8-celled

(B) 7-nucleate and 7-celled

(C) 7-nucleate and 8-celled

(D) 8-nucleate and 7-celled

Correct Answer: (D) 8-nucleate and 7-celled

Solution:

Concept:

- A typical mature angiosperm embryo sac is the female gametophyte. The usual Polygonum-type embryo sac has eight nuclei arranged within seven cells.
- Count nuclei and cells separately: the central cell contains two polar nuclei, whereas each of the other six cells initially contains one nucleus.

Step 1: Count the cells at the two poles At the micropylar end, the egg apparatus consists of one egg cell and two synergids. These form three separate cells, each with one nucleus. At the chalazal end, three antipodal cells are present, again with one nucleus in each. The two ends therefore contribute six cells and six nuclei together.

Step 2: Include the central cell The large central cell lies between the two groups and contains the remaining two nuclei, called polar nuclei. It is one cell rather than two cells because the two nuclei share the same central-cell cytoplasm. Adding it gives seven cells in total but eight nuclei. The polar nuclei may subsequently fuse to form a secondary nucleus; the standard description asked here is the typical eight-nucleate, seven-celled arrangement.

Step 3: Reject the alternative counts Option (A) reverses the required relationship and loses two nuclei. Options (B) and (C) give seven nuclei, so neither accounts for both polar nuclei in the standard mature embryo sac. Option (C) also incorrectly gives eight cells. Only option (D) records both the nuclear and cellular counts correctly.

Step 4: Conclusion The typical mature angiosperm embryo sac is 8-nucleate and 7-celled. Hence, the correct option is (D).

Quick Tip to Solve: Remember the central cell as the exception: one cell contains two polar nuclei, so the nucleus count exceeds the cell count by one.

38. Which one of the following hormones is not involved in the process of parturition? [5 marks]

(A) Estrogens

(B) Cortisol

(C) Oxytocin

(D) Prolactin

Correct Answer: (D) Prolactin

Solution:

Concept:

- Parturition is childbirth, involving coordinated uterine contractions and cervical dilation. Neural and hormonal signals establish a positive-feedback mechanism during labour.
- Oxytocin promotes uterine contractions, whereas prolactin primarily promotes milk production in the mammary glands after delivery.

Step 1: Identify the direct labour signal Signals from the fully developed fetus and placenta initiate mild uterine contractions called the fetal ejection reflex. This stimulates oxytocin release from the maternal posterior pituitary. Oxytocin strengthens uterine contractions, and stronger contractions stimulate further oxytocin secretion until the baby is expelled.

Step 2: Assess the supporting hormonal roles Estrogens help prepare the uterus for labour by increasing uterine responsiveness and promoting the contractile state. Fetal cortisol participates in fetal maturation and the endocrine changes associated with the onset of birth. Thus, neither estrogens nor cortisol is the best exception among the listed choices. Oxytocin is especially important in the positive-feedback cycle that sustains labour.

Step 3: Distinguish lactation from childbirth Prolactin, secreted by the anterior pituitary, acts on mammary tissue to support milk synthesis. Milk production is a postnatal nutritional function rather than the uterine expulsion mechanism asked about here. Do not confuse prolactin with oxytocin: oxytocin also causes milk ejection, but its role in uterine contraction makes it a parturition hormone. This distinction eliminates options (A), (B) and (C).

Step 4: Conclusion Prolactin is primarily concerned with milk production rather than the process of parturition. Hence, the correct option is (D).

Quick Tip to Solve: Separate the functions: oxytocin contracts the uterus and ejects milk; prolactin produces milk.

39. Which one of the following structures provide energy for sperm movement? [5 marks]

(A) Acrosome

(B) Head

(C) Middle piece

(D) Tail

Correct Answer: (C) Middle piece

Solution:

Concept:

- A human sperm has a head, neck, middle piece and tail. The structural region that generates usable energy is different from the region that produces the propulsive movement.
- Mitochondria are concentrated in the middle piece and produce ATP by cellular respiration; ATP powers the flagellar machinery of the tail.

Step 1: Locate the energy-producing organelles The sperm middle piece contains numerous mitochondria arranged around the axial filament. Their role is to provide ATP, the immediate energy source required for sustained movement. This mitochondrial concentration supplies energy close to the machinery that uses it, enabling the sperm to swim through the female reproductive tract.

Step 2: Distinguish energy supply from propulsion The tail undergoes coordinated bending movements that propel the sperm. It uses energy; it is not the region identified in the question as providing that energy. The wording therefore asks for the middle piece rather than the tail. Distinguishing the ATP-producing region from the moving region is the key to selecting the answer.

Step 3: Check the head and acrosome alternatives The head contains the condensed haploid nucleus, which delivers paternal genetic information. Its anterior cap, the acrosome, contains enzymes that help the sperm penetrate the coverings surrounding the ovum. These are essential for fertilisation but do not supply the energy for swimming. Options (A) and (B) describe penetration and genetic functions, while option (D) names the structure that moves. Option (C) correctly names the energy-supplying region.

Step 4: Conclusion The middle piece supplies energy for sperm movement through its abundant mitochondria. Hence, the correct option is (C).

Quick Tip to Solve: For sperm questions, pair the parts with functions: acrosome–penetration, nucleus–genes, middle piece–ATP, tail–propulsion.

40. Which one of the following hormones is at its peak during ovulation? [5 marks]

(A) Progesterone

(B) Estrogen

(C) Luteinising hormone

(D) Follicle stimulating hormone

Correct Answer: (C) Luteinising hormone

Solution:

Concept:

- Ovulation is the rupture of the mature Graafian follicle and release of the secondary oocyte near the middle of the menstrual cycle.
- A sharp mid-cycle surge of luteinising hormone (LH), secreted by the anterior pituitary, triggers follicular rupture and ovulation.

Step 1: Identify the event that triggers ovulation During the follicular phase, the developing ovarian follicle secretes increasing amounts of estrogen. High estrogen near mid-cycle produces positive feedback on the hypothalamic-pituitary system, leading to a sudden, pronounced rise in LH secretion. This LH surge is the characteristic hormonal event associated with ovulation.

Step 2: Connect the LH surge to the ovary The surge induces the final changes in the mature Graafian follicle, its rupture and release of the oocyte. LH also supports luteinisation of the ruptured follicle, which forms the corpus luteum. Thus, among the listed hormones, LH is the one identified by its conspicuous peak at the time of ovulation.

Step 3: Compare the other hormone profiles Estrogen rises strongly before ovulation and helps initiate the LH surge, but it is not the hormone whose distinctive surge is the immediate ovulatory trigger. Follicle stimulating hormone supports follicular growth and shows a smaller mid-cycle increase. Progesterone rises mainly after ovulation because the corpus luteum secretes it during the luteal phase. These timings rule out (A), (B) and (D) as the best answer to the question.

Step 4: Conclusion Luteinising hormone reaches its characteristic mid-cycle peak and triggers ovulation. Hence, the correct option is (C).

Quick Tip to Solve: On a menstrual-cycle graph, locate the tallest narrow mid-cycle spike: it represents the LH surge that triggers ovulation.

41. Drugs and Drug Abuse

Read the following passage carefully and answer the given questions.

Use of drugs has been on the rise, especially among the youth. This is really a cause of concern as it could result in many harmful effects. Proper education and guidance would enable young people to safeguard themselves against these dangerous behaviour patterns and follow healthy lifestyles. The drugs which are commonly abused are opioids, cannabinoids and coca alkaloids. The majority of these are obtained from flowering plants. Some are obtained from fungi. Various plants, fruits and seeds having hallucinogenic properties have been used for hundreds of years in folk-medicine, religious ceremonies and rituals all over the globe. When these are taken for a purpose other than medicinal use or in amounts/frequency that impairs one's physical, physiological or psychological functions, it constitutes drug abuse. These days, some drugs are also being abused by some sports-persons.

Chemically, heroin is: [5 marks]

(A) Dichloroacetylene

(B) Diacetylmorphine

(C) Acetyl-pentene

(D) Di-methylacetylene

Correct Answer: (B) Diacetylmorphine

Solution:

Concept:

- Heroin is an opioid drug whose chemical name is diacetylmorphine. It is commonly called smack.
- Morphine is an alkaloid obtained from the latex of the poppy plant, *Papaver somniferum*. Acetylation of morphine gives heroin.

Step 1: Identify the chemical name The question asks for chemical identity, rather than the plant source or a street name. In NCERT terminology, heroin is diacetylmorphine: the prefix diacetyl indicates that two acetyl groups have been introduced into morphine. Thus the required name retains the morphine framework.

Step 2: Check the listed alternatives Diacetylmorphine in option (B) matches this identity. Dichloroacetylene in (A), acetyl-pentene in (C), and di-methylacetylene in (D) are not the chemical name of heroin. The presence of an acetyl-related word alone is insufficient; the complete name must identify the morphine derivative. Heroin acts as a depressant and slows body functions, consistent with its classification as an opioid.

Step 3: Conclusion Heroin is chemically diacetylmorphine. Hence, the correct option is (B).

Quick Tip to Solve: Remember the pair heroin–diacetylmorphine, and distinguish this chemical name from the common name smack.

42. Drugs and Drug Abuse

Read the following passage carefully and answer the given questions.

Use of drugs has been on the rise, especially among the youth. This is really a cause of concern as it could result in many harmful effects. Proper education and guidance would enable young people to safeguard themselves against these dangerous behaviour patterns and follow healthy lifestyles. The drugs which are commonly abused are opioids, cannabinoids and coca alkaloids. The majority of these are obtained from flowering plants. Some are obtained from fungi. Various plants, fruits and seeds having hallucinogenic properties have been used for hundreds of years in folk-medicine, religious ceremonies and rituals all over the globe. When these are taken for a purpose other than medicinal use or in amounts/frequency that impairs one's physical, physiological or psychological functions, it constitutes drug abuse. These days, some drugs are also being abused by some sports-persons.

Which one of the following drugs is not produced from *Cannabis* plant? [5 marks]

(A) Marijuana

(B) Hashish

(C) Smack

(D) Charas and ganja

Correct Answer: (C) Smack

Solution:

Concept:

- Cannabinoids are obtained from the inflorescences of *Cannabis sativa*; its parts and resin yield preparations such as marijuana, hashish, charas and ganja.
- Smack is heroin, an opioid derived from morphine. Its plant association is the poppy, not *Cannabis*.

Step 1: Group the Cannabis preparations Marijuana and hashish belong to the cannabinoid preparations associated with Cannabis. Charas and ganja also belong to this group. Accordingly, options (A), (B), and (D) all name Cannabis products and cannot answer the question, which explicitly asks for the drug not produced from that plant.

Step 2: Identify the exception Smack is the common name for heroin, chemically diacetylmorphine. It is obtained by modifying morphine, an alkaloid extracted from the latex of the poppy plant, *Papaver somniferum*. It therefore belongs to the opioid group rather than the Cannabis-derived cannabinoid group. Grouping the names by their source plant isolates smack as the single exception.

Step 3: Conclusion Smack is not produced from the Cannabis plant. Hence, the correct option is (C).

Quick Tip to Solve: For a source-plant question, separate poppy opioids such as heroin/smack from Cannabis preparations such as hashish and ganja.

43. Drugs and Drug Abuse

Read the following passage carefully and answer the given questions.

Use of drugs has been on the rise, especially among the youth. This is really a cause of concern as it could result in many harmful effects. Proper education and guidance would enable young people to safeguard themselves against these dangerous behaviour patterns and follow healthy lifestyles. The drugs which are commonly abused are opioids, cannabinoids and coca alkaloids. The majority of these are obtained from flowering plants. Some are obtained from fungi. Various plants, fruits and seeds having hallucinogenic properties have been used for hundreds of years in folk-medicine, religious ceremonies and rituals all over the globe. When these are taken for a purpose other than medicinal use or in amounts/frequency that impairs one's physical, physiological or psychological functions, it constitutes drug abuse. These days, some drugs are also being abused by some sports-persons.

A very effective sedative and painkiller, which is very useful in patients who have undergone surgery is: [5 marks]

(A) Morphine

(B) Heroin

(C) Cocaine

(D) Kanamycin

Correct Answer: (A) Morphine

Solution:

Concept:

- Morphine is a powerful opioid analgesic and sedative obtained from the opium poppy, *Papaver somniferum*.
- NCERT identifies morphine as useful for relieving pain in patients who have undergone surgery; a stimulant or an antibiotic does not match this description.

Step 1: Match the therapeutic description The two clues are a sedative action and effective pain relief after surgery. Morphine acts on opioid receptors and is a strong analgesic, so it directly matches this postoperative use. The question asks for the drug normally identified with this therapeutic role, not merely another substance that belongs to the broad opioid group.

Step 2: Eliminate the other drug classes Heroin is diacetylmorphine, commonly called smack, and is discussed here as a drug of abuse rather than the standard NCERT answer to postoperative pain relief. Cocaine is a coca alkaloid with stimulant effects and is not the described sedative. Kanamycin is an antibiotic used against susceptible bacteria; it is neither the opioid analgesic nor the sedative named in this context. Only morphine fits the full description.

Step 3: Conclusion Morphine is the effective sedative and painkiller useful in patients after surgery. Hence, the correct option is (A).

Quick Tip to Solve: Link postoperative pain relief with morphine; distinguish its analgesic role from cocaine stimulation and kanamycin antibacterial action.

44. Drugs and Drug Abuse

Read the following passage carefully and answer the given questions.

Use of drugs has been on the rise, especially among the youth. This is really a cause of concern as it could result in many harmful effects. Proper education and guidance would enable young people to safeguard themselves against these dangerous behaviour patterns and follow healthy lifestyles. The drugs which are commonly abused are opioids, cannabinoids and coca alkaloids. The majority of these are obtained from flowering plants. Some are obtained from fungi. Various plants, fruits and seeds having hallucinogenic properties have been used for hundreds of years in folk-medicine, religious ceremonies and rituals all over the globe. When these are taken for a purpose other than medicinal use or in amounts/frequency that impairs one's physical, physiological or psychological functions, it constitutes drug abuse. These days, some drugs are also being abused by some sports-persons.

Which one of the following drugs is not normally used as medicine to help patients cope with mental illnesses? [5 marks]

(A) Chloramphenicol

(B) Amphetamines

(C) Benzodiazepines

(D) Barbiturates

Correct Answer: (A) Chloramphenicol

Solution:

Concept:

- An antibiotic acts against susceptible microorganisms, whereas psychoactive drugs affect the central nervous system and may have medical uses in treating mental-health conditions.
- NCERT lists drugs such as amphetamines, benzodiazepines and barbiturates among medicines used to help patients cope with mental illnesses when used appropriately.

Step 1: Classify the named medicines Chloramphenicol is an antibiotic. Its relevant medicinal function is treating bacterial infection, so it is not normally used to help patients cope with mental illnesses. This distinction concerns its normal therapeutic purpose, even though all the listed substances can be called drugs.

Step 2: Compare the remaining choices Amphetamines are central nervous system stimulants with specific medical applications. Benzodiazepines have calming and anxiety-reducing actions, and barbiturates are central nervous system depressants historically used for sedative purposes. These three are the psychoactive medicinal groups intended by the NCERT statement. The question does not say that all are appropriate for every mental illness; it asks which one lies outside the stated normal use. Chloramphenicol is the clear exception because it is antibacterial.

Step 3: Conclusion Chloramphenicol is an antibiotic and is not normally used as the stated medicine for mental illnesses. Hence, the correct option is (A).

Quick Tip to Solve: Look for the antibiotic among psychoactive drug names: chloramphenicol targets bacteria, while the other listed groups act on the central nervous system.

45. Drugs and Drug Abuse

Read the following passage carefully and answer the given questions.

Use of drugs has been on the rise, especially among the youth. This is really a cause of concern as it could result in many harmful effects. Proper education and guidance would enable young people to safeguard themselves against these dangerous behaviour patterns and follow healthy lifestyles. The drugs which are commonly abused are opioids, cannabinoids and coca alkaloids. The majority of these are obtained from flowering plants. Some are obtained from fungi. Various plants, fruits and seeds having hallucinogenic properties have been used for hundreds of years in folk-medicine, religious ceremonies and rituals all over the globe. When these are taken for a purpose other than medicinal use or in amounts/frequency that impairs one's physical, physiological or psychological functions, it constitutes drug abuse. These days, some drugs are also being abused by some sports-persons.

Which one of the following plants does not have hallucinogenic properties? [5 marks]

(A) *Atropa*

(B) *Erythroxylum*

(C) *Datura*

(D) *Rauwolfia*

Correct Answer: (D) *Rauwolfia*

Solution:

Concept:

- Hallucinogenic substances alter perception, thoughts and feelings by acting on the central nervous system. The question asks for the exception among the listed plants.
- A medicinal plant is not automatically a hallucinogenic plant: the nature of its active compounds and their effects decide the classification.

Step 1: Identify the exceptional plant *Rauwolfia* is associated with alkaloids such as reserpine, which has been used as an antihypertensive and tranquillising agent. In the standard classification tested here, it is not a source of hallucinogens. Its medicinal action must be distinguished from the perceptual disturbances associated with hallucinogenic drugs.

Step 2: Eliminate the other choices *Atropa* and *Datura* contain tropane alkaloids and are associated with hallucinogenic or delirium-producing effects. *Erythroxylum coca* yields cocaine, a central nervous system stimulant whose excessive use can cause hallucinations. Thus these three choices do not supply the requested exception; they cannot be selected merely because they also have other physiological effects.

Step 3: Conclusion The plant without hallucinogenic properties in the given classification is *Rauwolfia*. Hence, the correct option is (D).

Quick Tip to Solve: For a negative plant-source question, recall the active compound: Rauwolfia–reserpine distinguishes it from Datura, Atropa and coca.

46. Mendelian Disorders

Read the following passage carefully and answer the given questions.

Genetic disorders may be grouped into two categories - Mendelian disorders and Chromosomal disorders. Mendelian disorders are mainly determined by alteration or mutation in a single gene. These disorders are transmitted to the offspring on the same lines as in the principle of inheritance. The pattern of inheritance of such Mendelian disorders can be traced in a family by pedigree analysis. Most common and prevalent Mendelian disorders are Haemophilia, Cystic fibrosis, Sickle-cell anaemia, Colour blindness, Phenylketonuria, Thalassemia, etc. The Mendelian disorders may be dominant or recessive. By pedigree analysis, one can easily understand whether the trait in question is dominant or recessive. Similarly, the trait may also be linked to the sex chromosome or an autosome.

Which one of the following diseases is an autosomal dominant disorder? [5 marks]

(A) Sickle-cell anaemia

(B) Myotonic dystrophy

(C) Phenylketonuria

(D) Thalassemia

Correct Answer: (B) Myotonic dystrophy

Solution:

Concept:

- An autosomal dominant disorder is determined by an allele on an autosome that can produce the phenotype in a heterozygous individual.
- Autosomal recessive disorders generally require two recessive alleles for the affected phenotype; being Mendelian does not by itself mean that a disorder is dominant.

Step 1: Identify the dominant disorder Myotonic dystrophy is inherited as an autosomal dominant disorder. Its causal genetic change can be transmitted by either sex, and an affected heterozygous parent can transmit the disorder to a child. This distinguishes its inheritance category from the recessive examples in the options.

Step 2: Classify and reject the alternatives Sickle-cell anaemia is an autosomal recessive disorder associated with an altered beta-globin chain; phenylketonuria is an autosomal recessive metabolic disorder; and thalassemia is also treated as an autosomal recessive disorder in this classification. These disorders may occur in both sexes because the relevant genes are autosomal, but that fact does not make them dominant. The required combination is autosomal location together with dominant expression, which selects myotonic dystrophy.

Step 3: Conclusion Myotonic dystrophy is the autosomal dominant disorder among the listed diseases. Hence, the correct option is (B).

Quick Tip to Solve: Classify inheritance in two separate steps: autosomal versus sex-linked, then dominant versus recessive. Myotonic dystrophy is autosomal dominant.

47. Mendelian Disorders

Read the following passage carefully and answer the given questions.

Genetic disorders may be grouped into two categories - Mendelian disorders and Chromosomal disorders. Mendelian disorders are mainly determined by alteration or mutation in a single gene. These disorders are transmitted to the offspring on the same lines as in the principle of inheritance. The pattern of inheritance of such Mendelian disorders can be traced in a family by pedigree analysis. Most common and prevalent Mendelian disorders are Haemophilia, Cystic fibrosis, Sickle-cell anaemia, Colour blindness, Phenylketonuria, Thalassemia, etc. The Mendelian disorders may be dominant or recessive. By pedigree analysis, one can easily understand whether the trait in question is dominant or recessive. Similarly, the trait may also be linked to the sex chromosome or an autosome.

Which one of the following substitutions is a cause of sickle-cell anaemia? [5 marks]

(A) Substitution of valine by aspartic acid at the sixth position of the beta globin chain.

(B) Substitution of glutamic acid by alanine at the sixth position of the beta globin chain.

(C) Substitution of glutamic acid by valine at the sixth position of the beta globin chain.

(D) Substitution of glycine by methionine at the sixth position of the beta globin chain.

Correct Answer: (C) Substitution of glutamic acid by valine at the sixth position of the beta globin chain.

Solution:

Concept:

- Sickle-cell anaemia results from a point mutation in the gene encoding the beta-globin polypeptide of haemoglobin.
- The characteristic molecular change replaces glutamic acid with valine at the sixth amino-acid position of the beta-globin chain.

Step 1: Track the normal-to-mutant substitution The normal beta-globin chain has glutamic acid at position six. In sickle haemoglobin this residue is replaced by valine. The direction is important: the original amino acid is glutamic acid, and the incoming amino acid is valine. At the coding-DNA level the corresponding codon changes from GAG to GTG; the mRNA codon therefore changes from GAG to GUG.

Step 2: Connect the change and exclude alternatives Valine is nonpolar whereas glutamic acid is charged. This substitution favours abnormal association of deoxygenated sickle haemoglobin, leading to distortion of red blood cells into the characteristic sickle shape. Option (A) names valine and aspartic acid in a different substitution, option (B) wrongly gives alanine as the replacement, and option (D) gives glycine and methionine. None describes the defining sixth-position glutamic-acid-to-valine change.

Step 3: Conclusion Substitution of glutamic acid by valine at the sixth position of the beta-globin chain causes sickle-cell anaemia. Hence, the correct option is (C).

Quick Tip to Solve: Remember the direction as Glu-6 to Val in beta-globin; reversing the replacement or changing the chain gives the wrong mutation.

48. Mendelian Disorders

Read the following passage carefully and answer the given questions.

Genetic disorders may be grouped into two categories - Mendelian disorders and Chromosomal disorders. Mendelian disorders are mainly determined by alteration or mutation in a single gene. These disorders are transmitted to the offspring on the same lines as in the principle of inheritance. The pattern of inheritance of such Mendelian disorders can be traced in a family by pedigree analysis. Most common and prevalent Mendelian disorders are Haemophilia, Cystic fibrosis, Sickle-cell anaemia, Colour blindness, Phenylketonuria, Thalassemia, etc. The Mendelian disorders may be dominant or recessive. By pedigree analysis, one can easily understand whether the trait in question is dominant or recessive. Similarly, the trait may also be linked to the sex chromosome or an autosome.

Which one of the followings is an example of an inborn error of metabolism and inherited as autosomal recessive trait? [5 marks]

(A) Phenylketonuria

(B) Thalassemia

(C) Haemophilia

(D) Colour Blindness

Correct Answer: (A) Phenylketonuria

Solution:

Concept:

- An inborn error of metabolism is an inherited defect that disrupts a biochemical pathway, often through deficiency of an enzyme.
- Phenylketonuria is an autosomal recessive disorder in which conversion of phenylalanine to tyrosine is impaired.

Step 1: Identify the defective metabolic pathway In phenylketonuria, deficiency of phenylalanine hydroxylase impairs the normal conversion of phenylalanine into tyrosine. Phenylalanine consequently accumulates and is diverted into alternative products, including phenylpyruvic acid. The accumulated substances can harm the developing nervous system. This direct defect in an amino-acid metabolic pathway explains the term inborn error of metabolism.

Step 2: Apply the inheritance requirement and eliminate alternatives Phenylketonuria is inherited as an autosomal recessive trait: affected individuals possess two disease-associated alleles, while heterozygous carriers generally do not show the disorder. Thalassemia is autosomal recessive but is primarily a defect in globin-chain synthesis, rather than the classic enzyme-based metabolic error asked here. Haemophilia and the commonly taught red-green colour blindness are X-linked recessive conditions, so they do not satisfy the autosomal requirement. Phenylketonuria meets both parts of the description.

Step 3: Conclusion Phenylketonuria is the inborn error of metabolism inherited as an autosomal recessive trait. Hence, the correct option is (A).

Quick Tip to Solve: Link phenylketonuria to the blocked phenylalanine-to-tyrosine pathway, then check that its inheritance is autosomal recessive.

49. Mendelian Disorders

Read the following passage carefully and answer the given questions.

Genetic disorders may be grouped into two categories - Mendelian disorders and Chromosomal disorders. Mendelian disorders are mainly determined by alteration or mutation in a single gene. These disorders are transmitted to the offspring on the same lines as in the principle of inheritance. The pattern of inheritance of such Mendelian disorders can be traced in a family by pedigree analysis. Most common and prevalent Mendelian disorders are Haemophilia, Cystic fibrosis, Sickle-cell anaemia, Colour blindness, Phenylketonuria, Thalassemia, etc. The Mendelian disorders may be dominant or recessive. By pedigree analysis, one can easily understand whether the trait in question is dominant or recessive. Similarly, the trait may also be linked to the sex chromosome or an autosome.

α-thalassemia is controlled by the genes: [5 marks]

(A) HBB and HB1 on chromosome 11 of each parent

(B) HAA1 and HAB1 on chromosome 16 of each parent

(C) HBA1 and HBA2 on chromosome 16 of each parent

(D) HBB and HAA on chromosome 11 of each parent

Correct Answer: (C) HBA1 and HBA2 on chromosome 16 of each parent

Solution:

Concept:

- Thalassemia is an inherited disorder in which synthesis of one of the globin chains of haemoglobin is reduced. The chain affected distinguishes alpha-thalassemia from beta-thalassemia.
- The alpha-globin genes are HBA1 and HBA2, situated on chromosome 16. HBB, on chromosome 11, encodes beta-globin and is associated with beta-thalassemia.

Step 1: Identify the affected globin chain The prefix α identifies the alpha-globin chain of haemoglobin. Therefore, the required genes must encode alpha-globin rather than beta-globin. Normal adult haemoglobin contains two alpha and two beta chains, so defects in either chain can impair haemoglobin production, but they define different forms of thalassemia.

Step 2: Locate the alpha-globin genes HBA1 and HBA2 are the two alpha-globin genes on chromosome 16. An individual normally inherits a chromosome 16 carrying these two genes from each parent, giving four alpha-globin gene copies in all. Loss or reduced expression of these genes decreases alpha-chain production; the severity depends on how many copies are affected.

Step 3: Compare the gene names and chromosomes in the options Option (C) gives both correct gene names and the correct chromosome. Options (A) and (D) refer to chromosome 11 and include HBB, which belongs to the beta-globin locus rather than the alpha-globin locus. Option (B) mentions chromosome 16 but gives HAA1 and HAB1 instead of the alpha-globin genes HBA1 and HBA2; the correct chromosome alone is insufficient.

Step 4: Conclusion α-thalassemia involves the HBA1 and HBA2 genes on chromosome 16 inherited from each parent. Hence, the correct option is (C).

Quick Tip to Solve: Link HBA with alpha-globin and chromosome 16; link HBB with beta-globin and chromosome 11. Check both the gene names and the chromosome before selecting an option.

50. Mendelian Disorders

Read the following passage carefully and answer the given questions.

Genetic disorders may be grouped into two categories - Mendelian disorders and Chromosomal disorders. Mendelian disorders are mainly determined by alteration or mutation in a single gene. These disorders are transmitted to the offspring on the same lines as in the principle of inheritance. The pattern of inheritance of such Mendelian disorders can be traced in a family by pedigree analysis. Most common and prevalent Mendelian disorders are Haemophilia, Cystic fibrosis, Sickle-cell anaemia, Colour blindness, Phenylketonuria, Thalassemia, etc. The Mendelian disorders may be dominant or recessive. By pedigree analysis, one can easily understand whether the trait in question is dominant or recessive. Similarly, the trait may also be linked to the sex chromosome or an autosome.

Failure of segregation of chromatids during cell division results in: [5 marks]

(A) Apomixis

(B) Aneuploidy

(C) Polyploidy

(D) Parthenocarpy

Correct Answer: (B) Aneuploidy

Solution:

Concept:

- Chromatids normally segregate to opposite poles during anaphase so that daughter cells receive the appropriate chromosome complement. Failure of this separation is called nondisjunction.
- Aneuploidy is the gain or loss of individual chromosomes rather than a change involving complete chromosome sets. Nondisjunction can produce cells with an extra chromosome or a missing chromosome.

Step 1: Trace the consequence of failed segregation When sister chromatids separate normally, each daughter cell receives one copy of the chromosome. If the chromatids fail to separate, both may move to the same pole. One daughter cell then receives an extra copy of that chromosome and the other receives none of that chromosome from the separating pair. The chromosome number becomes unequal between the daughter cells.

Step 2: Identify the numerical chromosome abnormality This gain or loss concerns an individual chromosome, so the result is aneuploidy. In a diploid context, a gain of one chromosome can give $2n+1$, whereas a loss can give $2n-1$. Such changes differ from a mutation affecting only the sequence of one gene: nondisjunction changes chromosome number and can alter the dosage of many genes simultaneously.

Step 3: Distinguish the other processes Polyploidy means an increase in whole chromosome sets, such as $3n$ or $4n$, rather than the gain or loss of particular chromosomes described here. Apomixis is seed formation without fertilisation and is a mode of asexual reproduction. Parthenocarpy is fruit development without fertilisation, often producing seedless fruits. Neither term names the chromosomal imbalance caused by failed chromatid segregation.

Step 4: Conclusion Failure of segregation of chromatids causes nondisjunction and can result in aneuploidy, the gain or loss of individual chromosomes. Hence, the correct option is (B).

Quick Tip to Solve: Distinguish aneuploidy, a change in individual chromosomes, from polyploidy, a change in complete chromosome sets. A segregation failure points first to nondisjunction.